Notes on the Red-billed Leiothrix in Hawaii

HARVEY I. FISHER and PAUL H. BALDWIN[1]

THE NAME JAPANESE HILL ROBIN often used in Hawaii for *Leiothrix lutea* (Scopoli) is an unfortunate misnomer, as is Pekin Nightingale, because the bird does not occur in the wild in Japan nor does it occur as far north as Shanghai, much less Pekin or Peiping.

Henshaw (1911: 63) recommended the introduction of this species into Hawaii as early as 1911 and noted that it lives to some extent on insects and small fruits. Caum (1933: 38–39) states that the species was first introduced into the Territory of Hawaii in 1918 by Mrs. Dora Isenberg, who liberated several birds on the island of Kauai. However, the records kept by the Territorial Board of Agriculture and Forestry indicate several small importations previous to this time (Table 1). These probably were made for cage purposes, but some of the long-time residents believe *Leiothrix* was established in the Hawaiian Islands before 1918 by escapees from cages.

In Table 1 are summarized all importations of the species shown by official records. It is worthy of note that the table does not include the importations of 1918 and 1928 from San Francisco mentioned by Caum (*loc. cit.*). There may have been other unrecorded introductions. The table does show a total of 41 importations, including some 1,037 individuals. These individuals have been released on all the larger islands of the southeastern end of the Hawaiian Chain; the islands are Kauai, Oahu, Molokai, Maui, and Hawaii.

From official records the only indication

[1] Department of Zoology and Entomology, University of Hawaii, and Bernice P. Bishop Museum, Honolulu, respectively.

TABLE 1

PORTS OF EMBARKATION AND SUMMARY OF DATES AND NUMBERS OF *Leiothrix* IMPORTED INTO HAWAII

YEAR	PORT OF EMBARKATION					TOTAL
	Hongkong	Sydney	Shanghai	Kobe	Yokohama	
1911	1	....	....	....	....	1
1913	2, 6	....	....	....	3	11
1915	....	....	....	....	4	4
1916	5	2	....	....	....	7
1917	....	....	....	....	1, 4, 6, 3	14
1918	....	....	....	....	2	2
1919	2, 12, 12	....	....	....	....	26
1922	1	....	....	....	....	1
1923	....	....	3	....	....	3
1924	....	....	2	....	....	2
1928	3, 50	....	....	40, 30, 19	....	142
1929	....	....	....	6, 184	....	190
1932	....	....	....	....	1	1
1933	....	....	1	....	7	8
1934	....	....	....	75	....	75
1935	....	....	....	....	28	28
1936	1, 4, 1, 80	....	200	....	100, 37, 36	459
1937	1	....	2	....	60	63
Totals	181	2	208	354	292	1,037

we have of the original home of these introduced birds is the name of the port from which they were shipped, and this tells little. It was hoped that the subspecific determination of the Hawaiian birds might aid in revealing the native home of the introduced stock. However, H. G. Deignan, of the United States National Museum, has graciously examined 15 of our specimens from the Hawaiian Islands and has identified them as *Leiothrix lutea lutea.* The type locality of this race is the mountains of Anhwei Province south of the Yangtze. Since *lutea* ranges over all of China south of the Yangtze and east of the Kansu frontier, the original home of the breeding stock now in the Hawaiian Islands cannot be further specified.

DISTRIBUTION IN THE HAWAIIAN ISLANDS

Caum (1933: 39) noted that large flocks were present on Kauai and rightly assumed that the birds were breeding successfully on that island. However, he was uncertain about the status of the species on other islands, simply saying that the birds were "reported" to be breeding on Molokai, Maui, and Hawaii and "believed" to be breeding on Oahu. Subsequent unpublished observations have indicated that the birds are reproducing and are increasing the extent of their ranges on Hawaii, Oahu, Molokai, Kauai, and Maui. The bird is abundant, widespread, and nesting successfully on Hawaii. It is numerous and nesting in the Koolau and Waianae mountain ranges on Oahu. In early June, 1945, adults were observed feeding nearly fledged young in the mountain valleys at Mapulehu, Molokai, at an elevation of 500 feet. On Maui it is generally present in the moderately wet to wet forests of Haleakala and probably West Maui.

The vertical distribution on individual islands is unrecorded except on Oahu, Molokai, Maui, and Hawaii, where we have observed the species. On Oahu the species ranges from 400 to 3,000 feet in the Koolau Range and probably goes to about 4,000 feet in the Waianae Mountains. In other words, its vertical distribution includes all elevations available except those below 400 feet, and it seems likely that the species might be found below this level if all suitable cover conditions in deep valleys were to be investigated. Although the altitudinal range is considerable, the birds are most abundant above 600 to 800 feet; this fact may be due to the lack of sufficient cover at lower elevations.

On Hawaii the bird has been found chiefly at elevations ranging from near sea level (Puna district and windward Hawaii) to 7,500 feet on Mauna Loa. We may assume that the upward limit of their livable range on Hawaii is between 8,000 and 9,000 feet. However, there is no definite upper limit to the distribution in fall and early winter, when the birds band together and wander all over the island. Flocks have frequently been seen at more than 13,500 feet on Mauna Loa, but these flocks are soon reduced by deaths caused by exposure and starvation.

Temperature may be a factor in limiting upward distribution; this is indicated by increased mortality rates above 9,000 feet on Hawaii, where the mean temperature is 40° to 50° F. with but little seasonal variation. However, it is not likely that temperature is the important factor below this altitude, and even above 9,000 feet, food, wind, and cover conditions are probably the more important limiting factors.

Throughout its range (vertical and horizontal) the species is limited to the more moist, forested areas having a dense understory of plant growth. On Oahu this means it is restricted to the mountain valleys; seldom is the bird observed on the higher ridges except during its movements from one valley to another. Despite the bird's proclivity for moist valleys, rainfall apparently is not the determining factor except possibly in areas having less than 40 inches a year, for yearly

averages of precipitation in its observed range on Oahu vary from 30 to 200 inches. On Hawaii the species is rare or absent in areas having less than 20 inches a year; this is true in the leeward districts. In the Kau district, where rainfall is 20 inches or less in much of the lowland, *Leiothrix* is rare below 3,000 feet and absent below 2,500 feet. On Maui the annual rainfall in parts of the range of the species is 350 inches.

Presence or absence of surface water may be a significant factor. The species has often been observed bathing in water up to 2 inches in depth. Further, the birds are most frequently observed within a few hundred yards of such water. We have on several occasions noted birds drinking rain water caught in basins formed by the large fallen leaves of the ti plant (*Cordyline terminalis*) and the kamani tree (*Terminalia Catappa*).

HABITAT IN THE HAWAIIAN ISLANDS

A cover of dense vegetation near the ground is the major characteristic of the habitat of *Leiothrix*. Without exception the birds are found in areas having such a growth. It seems immaterial whether or not a canopy is formed above this undergrowth, as long as there is a thicket 10 to 15 feet in depth. We have never found this species feeding, nesting, or even remaining long in the large plantings of imported ironwood (*Casuarina*) or exotic *Eucalyptus;* there is rarely any ground growth in such places. The birds are frequently found in guava (*Psidium Guajava*) thickets not having a high canopy.

On Oahu the species is most abundant in the dense understory of forested and partly forested areas on the floors and steep slopes of the valleys. Usually there is in this habitat a stream, a small pond, or some temporary catch basins (fallen leaves, concavities in rocks) to hold rain water. On the extremely steep slopes of Manoa Valley, Oahu, at 1,100 feet where the rainfall is between 100 and 150 inches annually is a "typical" habitat. Here are scattered ohia lehua (*Metrosideros collina* var. *polymorpha*) trees up to 12 and 15 feet in height, interspersed with koa (*Acacia Koa*) trees up to 30 feet high and with kukui nut (*Aleurites moluccana*) trees. These three kinds of trees form in many places a loose, open canopy. In certain areas the kukui trees form a dense canopy. The understory consists of ti plants (*Cordyline terminalis*) up to 8 feet in height, a few *Gardenia Remyi* trees, and an occasional white hibiscus (*Hibiscus Arnottianus*). The lowest-growing vegetation is made up chiefly of palm foxtail (*Setaria palmifolia*) and oi shrubs (*Stachytarpheta cayennensis*). This growth is in many places so dense that it is difficult to penetrate. A further factor in creating an almost impenetrable thicket is the presence near the ground of many fallen branches. Also, in a few places the intertwining branches of the hau tree (*Hibiscus tiliaceus*) add to the maze (Fig. 1).

FIG. 1. Thicket formed by branches of the hau tree (*Hibiscus tiliaceus*) in Nuuanu Valley, Oahu, at 1,000 feet elevation.

On Hawaii this babbler is most abundant in forests from 1,000 to 5,000 feet elevation and with 40 or more inches of rain each year. Forests with a variety of habitats, such as koa forest partly modified by cattle grazing and with thimbleberries (*Rubus rosaefolius*) and other fruiting plants, harbor large numbers of the species. The density reaches 80 to

100 birds an acre at times at Kipuka Puaulu (4,000 feet). Guava thickets at elevations of 1,000 to 2,000 feet are also tenanted in good numbers. However, virgin tree fern forests favorable to the native Hawaiian birds are in some areas without *Leiothrix*. A forest of this type at the Twin Craters (3,800 feet) in Hawaii National Park usually had not more than one individual per acre. Similar forests of the Upper Olaa Forest Reserve near a farming district exhibited a somewhat greater density.

On Maui in the Kipahulu Valley the virgin, undisturbed ohia lehua forests (elevation 4,000 to 6,000 feet and rainfall 250 to 350 inches a year) had very few birds of this species. In koa forests in this same valley, but between 2,000 and 4,000 feet elevation and with a rainfall of 150 to 250 inches a year, the population density of this species was slightly greater, an indication that the bird was generally present, but uncommon.

The birds are seldom seen more than 15 feet above the ground and then only when the ground cover is very thick, or when the birds are in heavy tree foliage. Only occasionally can they be observed in the higher strata of the ohia and koa trees. Most frequently the birds are heard in the low thickets and not seen. If one is quiet it is possible to observe the bird flitting from shrub to shrub next to the ground. These movements combine short fluttering flights and hops of a few inches.

FLOCKING

We have seldom observed a flight of more than approximately 50 feet, but others report that flights of 200 feet are not uncommon in the more open parts of the range of the species. Longer flights are more frequently found during the winter, when the birds are banded together into traveling groups of 20 or even 100 birds. Some of the flocks in favorable places seem to confine their movements to a limited area, as at Kipuka Puaulu on Hawaii. However, some observers think the flocks represent groups migrating into the lowlands for the winter. There is a movement at this time, but it is more of a general diffusion into peripheral areas not heavily occupied during the breeding season, and it is by no means limited to downward movements, for, as mentioned previously, in winter the birds appear conspicuously in the ohia lehua forest of Mauna Loa at high elevations.

By May at Kipuka Puaulu the bands have broken up, and most of the birds are segregated by pairs. By late summer (July and August) small bands of 4 to 12 birds are common. Consequently, it appears that flocks are re-formed almost immediately after parental duties at the nest are completed. However, some of the birds remain in flocks throughout most of the breeding season (March through June).

NESTING

Perhaps nesting occurs at all elevations found in the spring and summer range of *Leiothrix,* but on Oahu nests have been found only between 500 and 2,500 feet elevation. On Hawaii the highest elevation at which a nest was found was 6,100 feet at Kipuka Kulalio. Without exception on Oahu the nests have been less than 10 feet from the ground and located in the densest parts of the understory; one nest was only 18 inches above the ground. On Hawaii nests have been found from 3 to 7 feet from the ground. Choice of the nest site seems to depend not so much on the particular kind of vegetation as on its density, for nests on Oahu have been found in staghorn fern (*Dicranopteris linearis*), oi, palm foxtail, and guava, on the finer branches of low-growing hau trees, and attached to the stems of ti leaves. On Hawaii, sites selected for nests included dense shrubs (aalii, *Dodonaea viscosa;* pukeawe, *Styphelia Tameiameiae*), the branches of trees (mamani, *Sophora*

chrysophylla), and fronds of tree ferns (*Cibotium Chamissoi*).

Occupied nests have been found between March 3 and May 7 on Oahu, and from early March through June on Hawaii. It is likely, however, that further investigation on both islands would reveal a longer breeding period.

On March 3, 1945, a nest with four eggs was found at 1,200 feet on the west side of Manoa Valley, Oahu. A complete description of this nest follows, because we have been unable to find any published account of the nest of this species. The nest was located in a well-shaded spot beneath a koa tree and in a dense growth of the exotic palm foxtail. It was well concealed by the rank growth of the foxtail and would have passed unnoticed had not the bird flushed when the observer stopped some 18 inches from the nest, which was 36 inches from the ground.

Support for the nest was a fork near the terminal twigs of an oi shrub (*Stachytarpheta cayennensis*); the heaviest branch of the fork was only 2 mm. in diameter. The nest was attached to the fork by only a few fibers from the leaves of the foxtail, which were wound around the twigs and woven into the rim of the nest. While not swinging as free, for example, as the nest of an oriole, the nest was definitely pendulous.

The measurements of the outside of the top of the ovoid nest were 9 cm. by 11 cm.; corresponding dimensions of the inside were 4.5 cm. by 6 cm. Over-all depth of the nest was 8.5 cm., but the depth of the cavity was 5.5 cm. From these figures we may conclude that the walls of the nest vary between 2 and 3 cm. in thickness.

All materials used in constructing the nest came from one plant, the palm foxtail, which was available within a few inches of the nest site. On the outside, entire leaves (some 18 inches long and 1¼ inches wide) were loosely wrapped around the nest and tied into the nest by small fibers (fibrovascular bundles) from the leaves of the foxtail. However, the bulk of the nest was woven of longitudinally split leaves from which the epidermis and mesophyll had disappeared, leaving only 8 to 15 parallel fibers. The lining of the nest consisted of single fibers from the same plant; they were loosely laid in to form a springy inside surface for the nest. The only part of the nest not coming from the leaf of this grass was three rootlets (the largest was 25 cm. long and 1 mm. in diameter) woven into the rim of the nest. The rootlets gave additional rigidity to the free edge.

Because of certain differences in construction and in materials used it seems desirable to describe another nest, found May 18, 1940, at 6,100 feet at Kipuka Kulalio, Mauna Loa, Hawaii. It was suspended in an aalii tree from the crotch of a forked twig at a height of 6½ feet from the ground and was secured by grass stems bent over the arms of the crotch and incorporated into the wall of the nest. The outermost part of the nest was a sling of grass woven vertically from the rim on one side, under the nest, to the opposite rim. This was the sole support, as there was no base of twigs. Inside this sling, grass was woven in various directions to make up the wall, which was about 3 cm. thick. Grass was worked in horizontally along the rim. There was a lining of loosely woven grass, strands of which ran diagonally up the sides to bend down at the rim at angles of about 80° and run again across the floor of the nest. The whole structure was firm, but not compact. Light could be seen through the sides. A few leaves had been placed near the bottom and in the bottom. The materials in the nest were 85 per cent grass (60 per cent stems and 25 per cent leaves), 15 per cent leaves of aalii, a trace of rootlets in the rim, and a few feral goat hairs in the lining. Measurements of this nest were:

	GREATEST DIAMETER	LEAST DIAMETER	DEPTH
	cm.	cm.	cm.
Outside	11.5	9.0	9.0
Inside	5.5	4.5	5.5

EGGS

The egg is shiny, with an extremely pale-blue ground color and a ring of red-brown or purple splotches around the larger end. A few pale-brown splotches are found on the blunt end and the sides of the egg, less often at the apex. Small brown specks and dark scrawlings may overlie the brown and purple splotches, especially at the blunt end.

Weights and measurements of eggs from two clutches are given below. The weights were taken 3 days before the eggs hatched.

	WEIGHT	LENGTH	DIAMETER
	gm.	mm.	mm.
Clutch 1			
egg 1	2.4	20.9	16.5
egg 2	2.4	20.3	16.4
egg 3	3.0	21.3	16.5
Clutch 2			
egg 1	...	20.4	15.4
egg 2	...	20.3	15.5
egg 3	...	20.0	15.4
egg 4	...	20.9	15.6

The number of eggs observed in a clutch varied between two and four, with an average of about three (two nests with two eggs, two with three eggs, and three with four eggs).

HATCHING

The earliest hatching observed on Hawaii was on March 14, and the latest was on June 16. On Oahu these dates were March 10 and May 15.

Cracks were found in all three eggs of a clutch at 3:00 P.M. on May 22. The cracks appeared to have resulted from activity inside the egg. In one egg the cracks were just distal to the largest diameter. A second egg had cracks in various places around its greatest circumference, while the third had only one small hole immediately distal to the greatest diameter. By 5:00 P.M. two of the eggs had hatched. The shells had been removed from the nest and could not be found on the ground; apparently they were carried away by the parent. By 5:35 P.M. the third egg had broken open. The shell was broken in a ring just proximal to the largest diameter. The crown of the embryo was pressed against the cap of the shell. The hatching bird flexed its neck and then extended it, shoving the shell cap forward and freeing its head. After resting a few moments it worked its legs back and forth twice, simultaneously kicking its body forward and the shell backward.

DESCRIPTION AND DEVELOPMENT OF THE YOUNG

When the nestlings were 1 hour old they appeared as follows: skin, rich reddish apricot, except where feather follicles caused gray color as in humeral tract, dorsal surface of neck, upper part of wing, and mid-dorsal region, and over eye; bill, reddish apricot, except upper mandible (gray between nares and tip); egg tooth, whitish yellow; rictus, light yellowish apricot; legs and feet, apricot; claws, yellow. Down feathers were present above eye, along occiput and mid-dorsal line from interscapular region to posterior edge of oil gland.

When the young were 24 hours old the skin color was less reddish, and the gray feather tracts were more pronounced and extensive; plumules, absent in ventral tract; eyes, still closed and gray; legs, yellow-apricot; skin, loose in tibiofibular region and on neck, tight over belly; belly, more prominent and bulging than at hatching.

When the birds were 7 days of age the first primary feather was 15.5 mm. long and still within its sheath; bill, orange at edges, gray on ridge and side; rictus, whitish; legs, salmon.

When they were 11 days old the first primary was 33.5 mm. long and two thirds out of its sheath; central rectrices extended 3 mm. and 1 mm. out of their sheaths; plu-

mules, gone from back but present on crown and femoral tracts, sparse on crural tract; feathers forming fluffy covering over entire body. The primaries were lined with golden-yellow; breast, yellow-green; back, dark yellow-green; ventral tracts, whitish yellow-green; undercoverts of tail, yellow (still in sheaths); secondaries, black and dark green. The bill was dark salmon, but superficially gray; rictus, whitish along edge; legs, yellowish-tan; and claws, yellow-orange at tips.

The weights of the young are summarized:

AGE	SIBLING A	SIBLING B	SIBLING C
	gm.	gm.	gm.
1 day . . .	3.1	3.0	3.2
7 days . . .	13.0	13.9	13.5
11 days . . .	15.0	....	15.2

When the birds were 1 hour old, their movements were sluggish; the head was lifted to receive food, and swallowing was accomplished. When 24 hours old the nestlings could squirm around; they rested on their abdomens. They threw back their heads and opened their mouths frequently. Begging behavior and ejection of feces could be brought about by touching the nestling. When not active they lay curled up on their sides with legs and toes flexed. At 7 days of age they still were unable to crawl. At 11 days one sibling left the nest when the observer tipped it to look inside. It escaped into the bushes by moving along the ground in short flights (3 feet). The nestlings could perch well, and they shifted their footholds to compensate for movements of the nest. Low-pitched alarm notes were uttered when they were trying to escape capture.

FOOD

Animal matter found in the stomachs of 13 birds from Hawaii National Park came from various species of Hymenoptera, Diptera, Lepidoptera, and Mollusca. Plant objects included fruits of the thimbleberry (*Rubus rosaefolius*) and other fruits and stems. The proportion of animal to plant matter varied from all animal to all plant food, but the proportions usually were between 40:60 and 60:40 by volume. Grit was typically present in the gizzard.

Observational data on Oahu indicate that the birds also feed on the fruits of strawberry guava (*Psidium Cattleianum*), overripe papayas, petals of small flowers, and small new buds of various plants. *Leiothrix* has also been seen to capture insects which flew near its position, but in feeding on insects it does not fly out from a perch in typical flycatcher fashion.

BIRD MALARIA

Blood smears from 11 specimens of *Leiothrix* from Hawaii were examined by the U. S. Fish and Wildlife Service. *Plasmodium vaughani* was reported from one smear made from a bird taken near Kipuka Puaulu in Hawaii National Park.

INTERACTION WITH OTHER ANIMALS

Although at times *Leiothrix* seems to be a noisy, aggressive bird, we found no antagonism toward other avian species except on one occasion. An observer was at a nest of the species, and under the stress of excitement one of the adults drove a foraging Olive-green Creeper (*Paroreomyza bairdi mana*) from the nest tree.

Except for the Hawaiian Hawk on the island of Hawaii, there is no evidence to indicate that other avian species molest *Leiothrix* in any way. Elsewhere in the Hawaiian Islands, the only possible predators on this species are mammalian—the rat, the mongoose, wild dogs and cats, and feral hogs—and these would exert pressure on the population by destroying eggs and young.

REFERENCES

CAUM, EDWARD L. *The exotic birds of Hawaii.* Bernice P. Bishop Mus. Occas. Papers 10 (9), 55 p., 1933.

HENSHAW, HENRY W. Report of the Committee on the Introduction of Birds into the Hawaiian Islands. *Hawaii. Forester and Agr.* 8: 61–64, 1911.